

# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

|  |   |  |
|--|---|--|
| Applicant's or agent's file reference<br><b>M98/0122/PCT</b> | <b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below. |  |
| International application No.<br><b>PCT/GB 00/ 02828</b>     | International filing date (day/month/year)<br><b>21/07/2000</b>   | (Earliest) Priority Date (day/month/year)<br><b>24/07/1999</b> |

Applicant

**LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al.**

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of Invention is lacking** (see Box II).

**4. With regard to the title,**

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

**5. With regard to the abstract,**

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

**6. The figure of the drawing to be published with the abstract is Figure No.**

☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

☒ None of the figures.



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02828

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29D30/62 B29C45/28 B29C45/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29D B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.         |
|------------|---|-------------------------------|
| X          | US 3 134 137 A (R. C. IMMEL )<br>26 May 1964 (1964-05-26)<br><br>column 4, line 66 -column 6, line 3;<br>figures 5-9  | 1,4,5,<br>7-12,14,<br>16      |
| A          | FR 2 072 999 A (REIFENKOMBINAT FURSTENWA)<br>24 September 1971 (1971-09-24)<br><br>page 4, line 14 -page 5, line 18; figures<br>2,3   | 1-5,<br>7-12,<br>14-17        |
| A          | PATENT ABSTRACTS OF JAPAN<br>vol. 015, no. 404 (M-1168),<br>15 October 1991 (1991-10-15)<br>-& JP 03 166916 A (YOKOHAMA RUBBER CO<br>LTD:THE), 18 July 1991 (1991-07-18)<br>abstract; figures 1,2<br><br>-/-- | 1,2,4,5,<br>7-12,14,<br>16,17 |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

27 October 2000

Date of mailing of the international search report

06/11/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Fregosi, A



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02828

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                              | Relevant to claim No. |
|------------|---|-----------------------|
| A          | US 2 569 935 A (C. W. LEGUILLON ET AL.)<br>2 October 1951 (1951-10-02)<br>the whole document<br>----            | 1-6,<br>10-17         |
| A          | US 2 744 290 A (W. G. CORSON)<br>8 May 1956 (1956-05-08)<br>figures 5,7<br>column 3, line 12 - line 71<br>----- | 1-17                  |



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/02828

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s)  | Publication<br>date      |
|---|---|---------------------|-----------------------------|--------------------------|
| US 3134137                                | A | 26-05-1964          | NONE                        |                          |
| FR 2072999                                | A | 24-09-1971          | DE 2058109 A<br>SU 382269 A | 25-11-1971<br>22-05-1973 |
| JP 03166916                               | A | 18-07-1991          | NONE                        |                          |
| US 2569935                                | A | 02-10-1951          | NONE                        |                          |
| US 2744290                                | A | 08-05-1956          | NONE                        |                          |





## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE  
 in its capacity as elected Office

|  |  |
|--|--|
| <b>Date of mailing</b> (day/month/year)<br>11 April 2001 (11.04.01)          |  |
| <b>International application No.</b><br>PCT/GB00/02828                       | <b>Applicant's or agent's file reference</b><br>M98/0122/PCT     |
| <b>International filing date</b> (day/month/year)<br>21 July 2000 (21.07.00) | <b>Priority date</b> (day/month/year)<br>24 July 1999 (24.07.99) |
| <b>Applicant</b><br>FREAKLEY, Philip, Kenneth et al                          |  |

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
 21 February 2001 (21.02.01)

☐ in a notice effecting later election filed with the International Bureau on:  
 \_\_\_\_\_

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

|  |   |
|--|---|
| <b>The International Bureau of WIPO</b><br>34, chemin des Colombettes<br>1211 Geneva 20, Switzerland<br>Facsimile No.: (41-22) 740.14.35 | <b>Authorized officer</b><br>S. Mafla<br>Telephone No.: (41-22) 338.83.38 |
|--|---|



# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

|  |   |   |
|--|---|---|
| Applicant's or agent's file reference<br><b>M98/0122/PCT</b>                                     | <b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |   |
| International application No.<br><b>PCT/GB00/02828</b>   | International filing date (day/month/year)<br><b>21/07/2000</b>   | Priority date (day/month/year)<br><b>24/07/1999</b> |
| International Patent Classification (IPC) or national classification and IPC<br><b>B29D30/62</b> |   |   |
| Applicant<br><b>LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al.</b>                           |   |   |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
 

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:
 

I    ☒ Basis of the report

II   ☐ Priority

III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

IV  ☐ Lack of unity of invention

V    ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI  ☐ Certain documents cited

VII ☒ Certain defects in the international application

VIII ☐ Certain observations on the international application

|   |  |
|---|--|
| Date of submission of the demand<br><br><b>21/02/2001</b>   | Date of completion of this report<br><br><b>06.11.2001</b>                         |
| Name and mailing address of the International preliminary examining authority:<br><br><div style="display: flex; align-items: center;"> <div>             European Patent Office<br/>             D-80298 Munich<br/>             Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br/>             Fax: +49 89 2399 - 4465           </div> </div> | Authorized officer<br><br><b>Militzer, E</b><br><br>Telephone No. +49 89 2399 2895 |





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**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB00/02828

**I. Basis of the report**

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, pages:**

1-16 as originally filed

**Claims, No.:**

1-17 as received on 08/10/2001 with letter of 05/10/2001

**Drawings, sheets:**

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/GB00/02828

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

|                               |                  |
|-------------------------------|------------------|
| Novelty (N)                   | Yes: Claims 1-17 |
|                               | No: Claims       |
| Inventive step (IS)           | Yes: Claims 1-17 |
|                               | No: Claims       |
| Industrial applicability (IA) | Yes: Claims 1-17 |
|                               | No: Claims       |

2. Citations and explanations  
see separate sheet

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
see separate sheet



IN THE COURT OF CHANCERY

STATE OF DELAWARE



**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Document US 3 134 137 (D1) does not disclose a method of forming on a surface of an article a moulding from a flowable material wherein:

- the surface is contacted with a mobile mould matrix and material inlet arrangement to form a moulding cavity as required by step i);
- displacing the material inlet arrangement relative to the mould matrix and the surface to leave exposed flowable material as required by step iii);
- contacting the exposed flowable material, the mobile mould matrix and the surface with a forming member to form a mould cavity.

Consequently, the subject matter of claim 1 is new (Article 33(2) PCT).

These differing features are also not suggested in the prior art documents resulting that the subject matter of claim 1 is not rendered obvious by the prior art (Article 33(3) PCT).

For the same reasons the subject matter of apparatus claim 14 including the constructional features for carrying out the method is new and not rendered obvious by the prior art (Articles 33(2) and (3) PCT).

The subject matter of independent claim 17 is directed to a specific embodiment of claim 1 wherein the article has a toroidal or cylindrical shape and the inlet channels are provided along the length of the side wall of the article.

It can also be concluded that the features of claim 17 are neither disclosed nor rendered obvious by the prior art. Consequently, claim 17 meets the requirements of Articles 33(2) and (3) PCT.

The subject matter of claims 1, 14 and 17 is industrially applicable (Article 33(4) PCT).

The features of dependent claims 2 to 13, 15 and 16 represent further embodiments of the method according to claim 1 and apparatus according to claim 14 respectively.



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB00/02828

These claims meet also the requirements of the PCT regulation.

**Re Item VII**

**Certain defects in the international application**

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

The description has not be brought in conformity with the new claims as required by Rule 5.1(a)(iii) PCT.

Two typing errors have be found, one on page 2, line 17, in "injection port" and one on page 5, line 21, in "crosslinking".



# PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

ROBERTSON, James A. et al.  
McNeight & Lawrence  
Regent House, Heaton Lane  
Stockport, Cheshire, SK4 IBS  
GRANDE BRETAGNE

## PCT

### NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Rule 71.1)

|                                     |            |
|-------------------------------------|------------|
| Date of mailing<br>(day/month/year) | 06.11.2001 |
|-------------------------------------|------------|

|   |                               |
|---|-------------------------------|
| Applicant's or agent's file reference<br>M98/0122/PCT | <b>IMPORTANT NOTIFICATION</b> |
|---|-------------------------------|

|   |  |  |
|---|--|--|
| International application No.<br>PCT/GB00/02828 | International filing date (day/month/year)<br>21/07/2000 | Priority date (day/month/year)<br>24/07/1999 |
|---|--|--|

Applicant

LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

#### 4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

|                                       |                    |
|---------------------------------------|--------------------|
| Name and mailing address of the IPEA/ | Authorized officer |
|---------------------------------------|--------------------|



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D-80298 Munich  
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# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

## PCT

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL SEARCH REPORT  
OR THE DECLARATION

(PCT Rule 44.1)

To:

McNeight & Lawrence  
Regent House, Heaton Lane  
Stockport, Cheshire, SK4 1BS  
UNITED KINGDOM

Date of mailing  
(day/month/year)

06/11/2000

Applicant's or agent's file reference

M98/0122/PCT

**FOR FURTHER ACTION**

See paragraphs 1 and 4 below

International application No.

PCT/GB 00/ 02828

International filing date  
(day/month/year)

21/07/2000

Applicant

LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al.

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19:**

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

**Where?** Directly to the International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland  
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been selected in the demand or in a later election within 19 months from the priority date or could not be selected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Amélie Möller

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## NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

### INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

#### What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

#### When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

#### Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

#### How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

#### What documents must/may accompany the amendments?

##### Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.



## NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:  
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:  
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:  
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or  
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:  
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

### "Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

**It must be in the language in which the international application is to be published.**

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

### Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

### Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.



PATENT COOPERATION TREATY  
**PCT**

**INTERNATIONAL SEARCH REPORT**  
(PCT Article 18 and Rules 43 and 44)

|  |   |
|--|---|
| Applicant's or agent's file reference<br><b>M98/0122/PCT</b>   | <b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report.<br>(Form PCT/ISA/220) as well as, where applicable, item 5 below. |
| International application No.<br><b>GB 00/02828</b>            | International filing date (day/month/year)<br><b>21/07/2000</b>   |
| (Earliest) Priority Date (day/month/year)<br><b>24/07/1999</b> |   |

**LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al.**

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

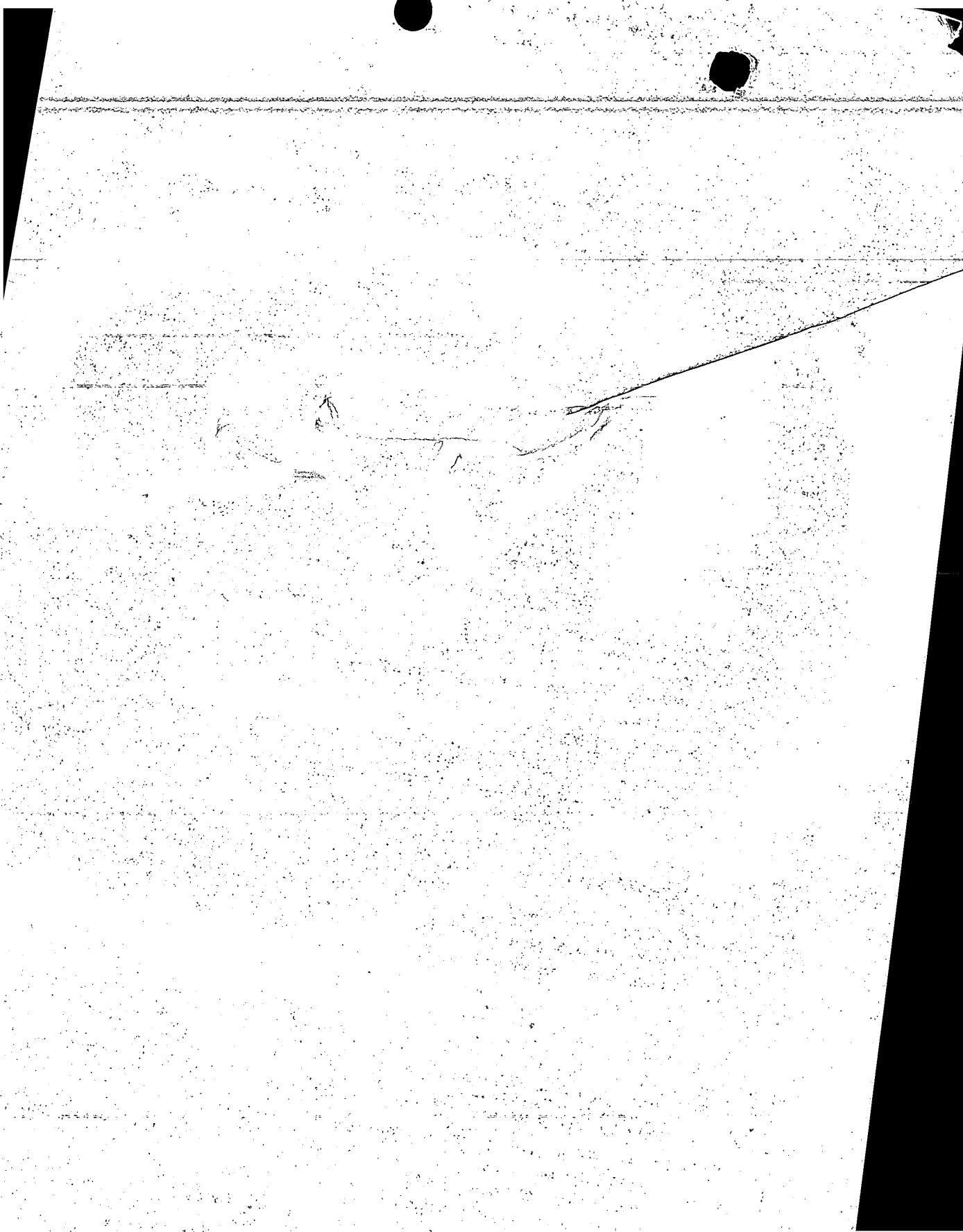
This International Search Report consists of a total of 3 sheets.  
☒ It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.
2. ☐ **Certain claims were found unsearchable** (See Box I).
3. ☐ **Unity of invention is lacking** (see Box II).
4. With regard to the **title**,
- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
- ☒ Non of the figures.

6. The figure of the **drawings** to be published with the abstract is Figure No.
- ☐ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02828

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29D30/62 B29C45/28 B29C45/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29D B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.         |
|------------|--|-------------------------------|
| X          | US 3 134 137 A (R. C. IMMEL )<br>26 May 1964 (1964-05-26)<br><br>column 4, line 66 -column 6, line 3;<br>figures 5-9   | 1,4,5,<br>7-12,14,<br>16      |
| A          | FR 2 072 999 A (REIFENKOMBINAT FURSTENWA)<br>24 September 1971 (1971-09-24)<br><br>page 4, line 14 -page 5, line 18; figures<br>2,3  | 1-5,<br>7-12,<br>14-17        |
| A          | PATENT ABSTRACTS OF JAPAN<br>vol. 015, no. 404 (M-1168),<br>15 October 1991 (1991-10-15)<br>-& JP 03 166916 A (YOKOHAMA RUBBER CO<br>LTD:THE), 18 July 1991 (1991-07-18)<br>abstract; figures 1,2<br><br>-/- | 1,2,4,5,<br>7-12,14,<br>16,17 |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

27 October 2000

Date of mailing of the international search report

06/11/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Fregosi, A





## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/02828

C.(Continuation) DOCUMENT CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                              | Relevant to claim No. |
|------------|---|-----------------------|
| A          | US 2 569 935 A (C. W. LEGUILLON ET AL.)<br>2 October 1951 (1951-10-02)<br>the whole document<br>---             | 1-6,<br>10-17         |
| A          | US 2 744 290 A (W. G. CORSON)<br>8 May 1956 (1956-05-08)<br>figures 5,7<br>column 3, line 12 - line 71<br>----- | 1-17                  |



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/02828

| Patent document cited in search report |   | Publication date | Patent family member(s)     | Publication date         |
|--|---|------------------|-----------------------------|--------------------------|
| US 3134137                             | A | 26-05-1964       | NONE                        |                          |
| FR 2072999                             | A | 24-09-1971       | DE 2058109 A<br>SU 382269 A | 25-11-1971<br>22-05-1973 |
| JP 03166916                            | A | 18-07-1991       | NONE                        |                          |
| US 2569935                             | A | 02-10-1951       | NONE                        |                          |
| US 2744290                             | A | 08-05-1956       | NONE                        |                          |



## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING  
SUBMISSION OR TRANSMITTAL  
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

MCNEIGHT & LAWRENCE  
Regent House  
Heaton Lane  
Stockport  
Cheshire SK4 1BS  
ROYAUME-UNI

|  |   |
|--|---|
| Date of mailing (day/month/year)<br>08 November 2000 (08.11.00)      | <b>IMPORTANT NOTIFICATION</b>   |
| Applicant's or agent's file reference<br>M98/0122/PCT                |   |
| International application No.<br>PCT/GB00/02828                      | International filing date (day/month/year)<br>21 July 2000 (21.07.00) |
| International publication date (day/month/year)<br>Not yet published | Priority date (day/month/year)<br>24 July 1999 (24.07.99)             |
| Applicant<br><br>LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al   |   |

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(\*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

| <u>Priority date</u>    | <u>Priority application No.</u> | <u>Country or regional Office<br/>or PCT receiving Office</u> | <u>Date of receipt<br/>of priority document</u> |
|-------------------------|---------------------------------|---|---|
| 24 July 1999 (24.07.99) | 9917364.3                       | GB  | 19 Sept 2000 (19.09.00)                         |

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 G n va 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Somsak Thiphrakesone

Telephone No. (41-22) 338.83.38



THE UNITED STATES OF AMERICA

DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT

# PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

**PCT**

## NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

MCNEIGHT & LAWRENCE  
Regent House  
Heaton Lane  
Stockport  
Cheshire SK4 1BS  
ROYAUME-UNI

|   |   |   |  |
|---|---|---|--|
| Date of mailing (day/month/year)<br>01 February 2001 (01.02.01) |   | <b>IMPORTANT NOTICE</b>                                   |  |
| Applicant's or agent's file reference<br>M98/0122/PCT           |   |   |  |
| International application No.<br>PCT/GB00/02828                 | International filing date (day/month/year)<br>21 July 2000 (21.07.00) | Priority date (day/month/year)<br>24 July 1999 (24.07.99) |  |
| Applicant<br>LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al  |   |   |  |

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:  
**AU, KP, KR, US**

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:  
**AE, AG, AL, AM, AP, AT, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EA, EE, EP, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OA, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU.**  
The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).
3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on  
01 February 2001 (01.02.01) under No. WO 01/07243.

### REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

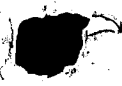
Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

### REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

|  |   |
|--|---|
| The International Bureau of WIPO<br>34, chemin des Colombettes<br>1211 Geneva 20, Switzerland<br>Facsimile No. (41-22) 740.14.35 | Authorized officer<br><br>J. Zahra<br>Telephone No. (41-22) 338.83.38 |
|--|---|



THE UNIVERSITY OF CHICAGO



## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

INFORMATION CONCERNING ELECTED  
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

MCNEIGHT & LAWRENCE  
Regent House  
Heaton Lane  
Stockport  
Cheshire SK4 1BS  
ROYAUME-UNI

|  |   |                       |
|--|---|-----------------------|
| Date of mailing (day/month/year)<br>11 April 2001 (11.04.01)   |   |                       |
| Applicant's or agent's file reference<br>M98/0122/PCT          |   | IMPORTANT INFORMATION |
| International application No.<br>PCT/GB00/02828                | International filing date (day/month/year)<br>21 July 2000 (21.07.00) |                       |
| Priority date (day/month/year)<br>24 July 1999 (24.07.99)      |   |                       |
| Applicant<br>LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al |   |                       |

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

AP : GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE

National : AU, BG, CA, CN, CZ, DE, IL, JP, KP, KR, MN, NO, NZ, PL, RO, RU, SE, SK, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM

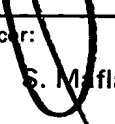
OA : BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG

National : AE, AG, AL, AM, AT, AZ, BA, BB, BR, BY, BZ, CH, CR, CU, DK, DM, DZ, EE, ES, FI, GB,  
GD, GE, GH, GM, HR, HU, ID, IN, IS, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MW,  
MX, MZ, PT, SD, SG, SI, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW

3. The applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed until 31 months from the priority date for all States designated for the purposes of obtaining a European patent.

|  |   |
|--|---|
| The International Bureau of WIPO<br>34, chemin des Colombettes<br>1211 Geneva 20, Switzerland<br><br>Facsimile No. (41-22) 740.14.35 | Authorized officer:<br><br>S. Maffla<br><br>Telephone No. (41-22) 338.83.38 |
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# PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

## PCT

To:

ROBERTSON, James A. et al.  
McNeight & Lawrence  
Regent House, Heaton Lane  
Stockport, Cheshire, SK4 IBS  
GRANDE BRETAGNE

**EINSCHREIBEN**

### NOTIFICATION OF RECEIPT OF DEMAND BY COMPETENT INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rules 59.3(e) and 61.1(b), first sentence  
and Administrative Instructions, Section 601(a))

Date of mailing  
(day/month/year)

**1 3. 03. 01**

Applicant's or agent's file reference  
**M98/0122/PCT**

#### IMPORTANT NOTIFICATION

International application No.

**PCT/GB 00/ 02828**

International filing date (day/month/year)

**21/07/2000**

Priority date (day/month/year)

**24/07/1999**

Applicant

**LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED et al.**

1. The applicant is hereby notified that this International Preliminary Examining Authority considers the following date as the date of receipt of the demand for international preliminary examination of the international application:

21/02/2001

2. This date of receipt is:

- ☒ the actual date of receipt of the demand by this Authority (Rule 61.1(b)).
- ☐ the actual date of receipt of the demand on behalf of this Authority (Rule 59.3(e)).
- ☐ the date on which this Authority has, in response to the invitation to correct defects in the demand (Form PCT/IPEA/404), received the required corrections.

3. ☐ **ATTENTION:** That date of receipt is **AFTER** the expiration of 19 months from the priority date. Consequently, the election(s) made in the demand does (do) not have the effect of postponing the entry into the national phase until 30 months from the priority date (or later in some Offices) (Article 39(1)). Therefore, the acts for entry into the national phase must be performed within 20 months from the priority date (or later in some Offices) (Article 22). For details, see the *PCT Applicant's Guide*, Volume II.

- ☐ (If applicable) This notification confirms the information given by telephone, facsimile transmission or in person on:

4. Only where paragraph 3 applies, a copy of this notification has been sent to the International Bureau.

Name and mailing address of the IPEA/

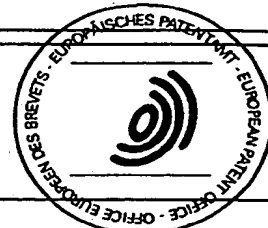


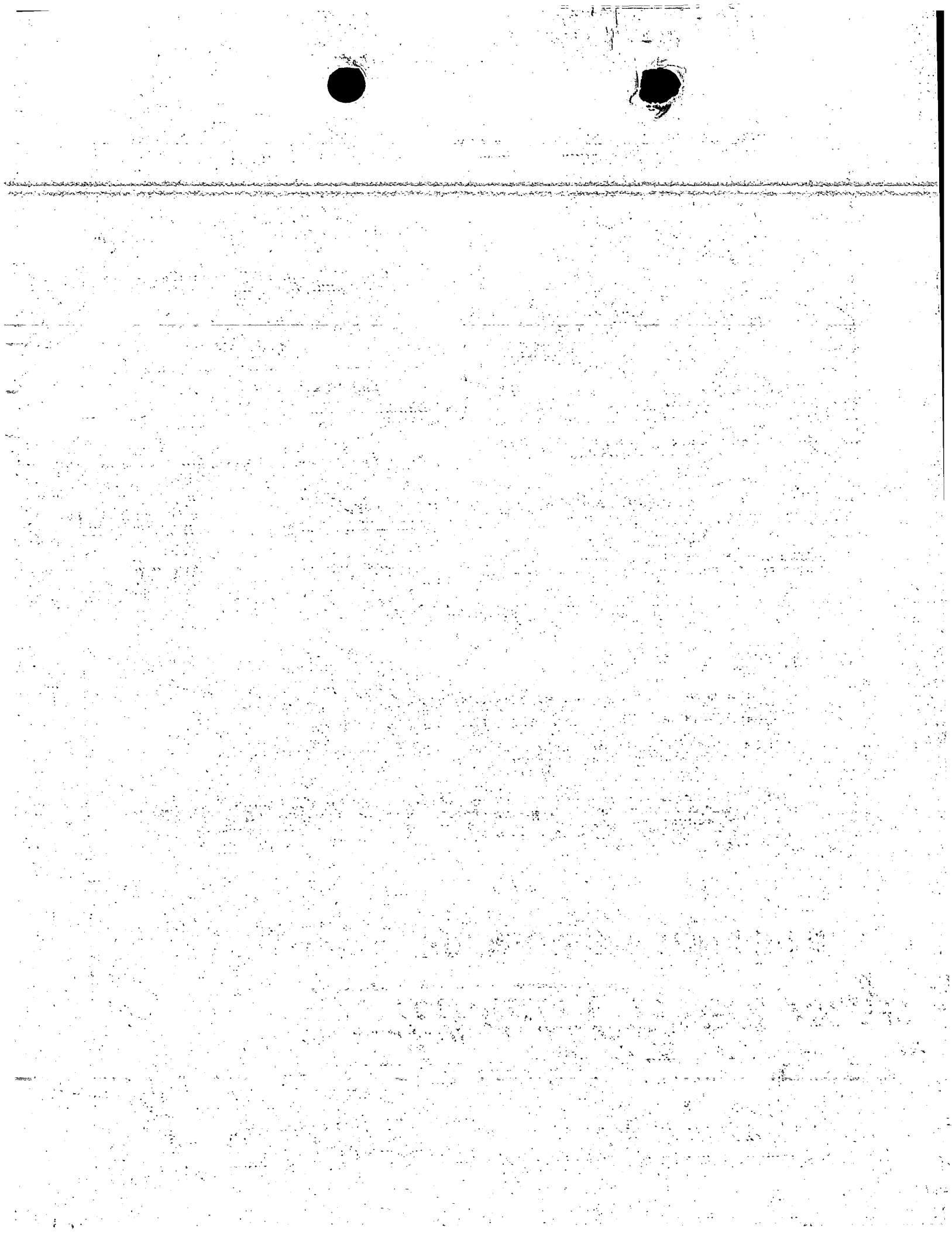
European Patent Office  
D-80298 Munich  
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Fax: (+49-89) 2399-4465

Authorized officer

**DUPONT-HUEPER M**

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(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
1 February 2001 (01.02.2001)

PCT

(10) International Publication Number  
**WO 01/07243 A1**

- (51) International Patent Classification<sup>7</sup>: **B29D 30/62, B29C 45/28, 45/14**
- (21) International Application Number: **PCT/GB00/02828**
- (22) International Filing Date: **21 July 2000 (21.07.2000)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:  
**9917364.3** **24 July 1999 (24.07.1999)** **GB**
- (71) Applicant (for all designated States except US): **LOUGHBOROUGH UNIVERSITY INNOVATIONS LIMITED** [GB/GB]; Loughborough University, Ashby Road, Loughborough, Leicestershire LE11 3TF (GB).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **FREAKLEY, Philip, Kenneth** [GB/GB]; 161 Main Street, Thornton, Leicester, Leicestershire LE67 1AH (GB). **LAWTON, Brian** [GB/GB]; 3 Alderney Close, Seabridge, Newcastle-under-Lyme, Staffordshire ST5 3PW (GB).
- (74) Agent: **MCNEIGHT & LAWRENCE**; Regent House, Heaton Lane, Stockport, Cheshire SK4 1BS (GB).
- (81) Designated States (national): **AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.**
- (84) Designated States (regional): **ARIPO** patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), **Eurasian** patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), **European** patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), **OAPI** patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:**  
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **DIRECT TYRE RETREADING**

(57) Abstract: The present invention is concerned with apparatus and methods of forming on a surface of an article a moulding from flowable material, and particularly for effecting a retreading of a tyre directly on a tyre casing.

WO 01/07243 A1



**REPLACED BY  
ART 34 AMDT****CLAIMS**

1. A method of forming on a surface of an article a moulding from flowable material comprising the steps of:

i) Contacting the surface with a mobile mould matrix and material inlet having at least one inlet channel to form a moulding cavity defining a first volume, the material inlet being displaceable relative to the surface and the mobile mould matrix;

ii) Filling the moulding cavity via the at least one inlet channel of the material inlet with flowable material;

iii) Stopping filling and displacing the material inlet relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the material inlet into the moulding cavity being severed;

iv) Contacting the exposed flowable material, the mobile mould matrix and the surface with a forming member to form a moulding cavity defining a second volume; and

v) Curing the flowable material to complete the moulding.

2. A method according to claim 1, the surface of the article having a cylindrical or toroidal shape.

3. A method according to claims 1 or 2 the article being a tyre casing.



0-216

1-4

1-4

1-4



**REPLACED BY  
ART 34 AMDT**

4. A method according to any one of the preceding claims, the flowable material being a rubber or thermoplastic in the melt state or a thermosetting resin in the melt state or a particulate material.
5. A method according to any one of the preceding claims, the at least one inlet channel having a reduced cross-section at the point at which material enters the moulding cavity.
6. A method according to any one of the preceding claims, said material inlet comprising a plurality of radially disposed inlet channels.
7. A method according to any one of claims 1-5, said material inlet having at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet.
8. A method according to claim 7, having a single continuous inlet channel about the whole of said material inlet.
9. A method according to any one of the preceding claims, the rate of flow of material into the moulding cavity being varied.
10. A method according to claim 9, the rate of flow of material into the moulding cavity being reduced prior to filling being stopped.
11. A method according to any one of the preceding claims, filling being stopped when the level of pressure upon the flowable material reaches a predetermined level.

YB



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12. A method according to any one of the preceding claims, the material inlet forming a side of the moulding cavity.

13. A method according to claim 12, the article being a tyre casing and the material inlet forming a tyre-edge side of the moulding.

14. Apparatus for forming on a surface of an article a moulding from flowable material, comprising a mobile mould matrix, material inlet and forming member, the material inlet being displaceable relative to the mobile mould matrix and the article.

15. Apparatus according to claim 14 additionally comprising at least one support member for the article.

16. Apparatus according to either one of claims 14 or 15, the material inlet additionally comprising a material injection system.

17. A method of forming from flowable material a moulding on a surface of a toroidal or cylindrical article having at least one side wall, comprising the steps of:

i) contacting the surface with a mobile mould matrix and material inlet having either one continuous inlet channel on the side wall or a plurality of discontinuous inlet channels along the length of the side wall, and simultaneously contacting the inlet channel or each of the inlet channels with an injection port, the mobile mould matrix and the injection ports defining a moulding cavity;

ii) filling the moulding cavity via the inlets with flowable material;

iii) stopping filling and displacing the injection port or each of the injection ports relative to the mobile mould matrix and the surface to leave exposed flowable



REPLACED BY  
ART 34 AMDT

material, the flow of material from the injection port or injection ports into the moulding cavity being severed;

iv) sealing the inlet or each of the inlets; and

v) curing the flowable material to complete the moulding.



# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 00/02828

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29D30/62 B29C45/28 B29C45/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29D B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.         |
|------------|---|-------------------------------|
| X          | US 3 134 137 A (R. C. IMMEL )<br>26 May 1964 (1964-05-26)<br><br>column 4, line 66 -column 6, line 3;<br>figures 5-9  | 1,4,5,<br>7-12,14,<br>16      |
| A          | FR 2 072 999 A (REIFENKOMBINAT FURSTENWA)<br>24 September 1971 (1971-09-24)<br><br>page 4, line 14 -page 5, line 18; figures<br>2,3   | 1-5,<br>7-12,<br>14-17        |
| A          | PATENT ABSTRACTS OF JAPAN<br>vol. 015, no. 404 (M-1168),<br>15 October 1991 (1991-10-15)<br>-& JP 03 166916 A (YOKOHAMA RUBBER CO<br>LTD:THE), 18 July 1991 (1991-07-18)<br>abstract; figures 1,2 | 1,2,4,5,<br>7-12,14,<br>16,17 |
|            | -/--  |                               |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

27 October 2000

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# INTERNATIONAL SEARCH REPORT

Patent No. : al Application No

PCT/GB 00/02828

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                              | Relevant to claim No. |
|------------|---|-----------------------|
| A          | US 2 569 935 A (C. W. LEGUILLON ET AL.)<br>2 October 1951 (1951-10-02)<br>the whole document<br>---             | 1-6,<br>10-17         |
| A          | US 2 744 290 A (W. G. CORSON)<br>8 May 1956 (1956-05-08)<br>figures 5,7<br>column 3, line 12 - line 71<br>----- | 1-17                  |



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/02828

| Patent document cited in search report |   | Publication date | Patent family member(s)     | Publication date         |
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## DIRECT TYRE RETREADING

The present invention is concerned with apparatus and methods of forming on a surface of an article a moulding from flowable material, and particularly for effecting a retreading of a tyre directly on a tyre casing.

Various methods of tyre retreading are known. Two particularly widely used techniques are Cold Capping and Hot Capping. In cold capping a precured (i.e. vulcanised) tread having a surface pattern is applied to a prepared tyre casing (i.e. a tyre which has been machined down to a predetermined size and any irregularities, e.g. pits or hollows, repaired) with a layer of uncured cushioning rubber separating the two. The arrangement of tyre tread, rubber cushioning and tyre casing held together in a tyre press is then autoclaved, curing (i.e. vulcanising/cross-linking) the cushioning rubber and bonding the tyre casing and tread. In hot capping a tread (having no surface pattern) is extruded (i.e. is un-cured), is applied to a prepared tyre casing and the tyre casing and tread is then moulded in a heated tyre press to form a tread pattern and to cure the tread, bonding it to the tyre casing.

Each technique has its advantages and disadvantages - cold capping enables a retreader to minimise capital investment by purchasing precured treads from suppliers, whereas hot capping requires greater capital investment but reduces the cost of consumables by not requiring the purchase of precured treads.

In both cases the predominant process cost is the time taken to heat the rubber in a tyre press to effect curing, which effectively determines the number of tyres which can be retreaded per tyre press per hour - heat must be conducted through a rubber layer about 20 mm thick to raise the temperature (typically from less than 80 °C) to about 160 °C, which is a slow process since rubber is an extremely good insulator.

This means that a typical curing time (for either process) is 60-90 minutes.

Retreading effected by moulding directly onto the surface of a tyre casing is known from e.g. US 4583928 and US 4139592, neither of which appears to have been commercially developed. Each of these requires the use of separate injection points in the crown (i.e. the equatorial plane) of the tyre tread mould. Effecting injection in the crown of the mould can be difficult and may require expensive machinery. Use of such methods may be achieved by e.g. sequential injection into each injection point (as opposed to simultaneous injection). This however would typically require a potentially time-consuming indexing of the tyre in order that injection points are presented in turn to an injection machine nozzle. This would also provide the potential for the formation of weak interfaces between the individually injected volumes of rubber. The provision of machinery for the simultaneous injection of rubber into the mould from crown injection points may be particularly expensive to achieve and operate. In particular, US 4583928 requires that a series of arcuate sections of a tyre casing have mouldings formed on them, one after the other, each moulding being cured before the next is made. This is particularly slow and provides a series of potentially weak weld lines. US 4139592 allows for the simultaneous use of a series of injection ports located across the equatorial plane of a moulding cavity to form a tread on a tyre casing. The specific positioning (on the equatorial plane) of the injection ports and their relative position forms an essential element of the invention, preventing the formation of weak weld lines. Curing advantageously takes place while the tyre is still in the injection mould (column 6 lines 20-27).

The present invention overcomes the prior art disadvantages, allowing for tread formation directly on a tyre casing, reducing the effort required in preparing tyre casings, and reducing the time required for curing. Advantageously, curing can take place separately from the tread forming apparatus (below), allowing optimum usage of the tread forming apparatus and helping to reduce the capital investment per tyre

retreaded per hour. As well as forming treads directly on tyre casings, treads can be formed on mould assemblies, allowing for the advantages of the separate curing step (above). The treads can subsequently be removal from the mould assemblies and used for cold or hot capping.

According to the present invention there is provided a method of forming on a surface of an article a moulding from flowable material comprising the steps of:

- i) Contacting the surface with a mobile mould matrix and material inlet having (i.e. defining) at least one inlet channel to form a moulding cavity defining a first volume, the material inlet being displaceable relative to the surface and the mobile mould matrix;
- ii) Filling the moulding cavity via the at least one inlet channel of the material inlet with flowable material;
- iii) Stopping filling and displacing the material inlet relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the material inlet into the moulding cavity being severed;
- iv) Contacting the exposed flowable material, the mobile mould matrix and the surface with a forming member to form a moulding cavity defining a second volume; and
- v) Curing the flowable material to complete the moulding.

The material inlet and forming member may define a side wall of the moulding cavity. In the case of cylindrical or toroidal articles, this would not be an equatorial plane such as a tyre surface.

The filling of the mould cavity of step (ii) may be effected simultaneously about the circumference (i.e. the perimeter) of the article. The provision of simultaneous injection minimises the potential for formation of weak interfaces. Forming is completed by step (iv). In the embodiments of the invention below, pressures in the mould cavity are predicted to reach a maximum of 8 MPa (80 bar) and therefore a rigid support structure for the apparatus defining the mould cavity is necessary, preferably a segmented one in order to enable easy removal.

As discussed above, the curing of flowable materials such as rubber can be a slow and time-consuming process which significantly affects the economics of a manufacturing process. By displacing the material inlet from the mobile mould matrix and the surface and replacing it with a forming member, the material inlet (and the system which supplies flowable material to it) is free to be used in another moulding process whilst curing takes place. Since the material inlet and the material supply system connected to it comprise typically the most expensive part of the apparatus used in the moulding process, this can lead to a very substantial reduction in the cost of apparatus required per moulding produced per hour. It also means that as soon as the moulding cavity has been filled and the material inlet replaced by the forming member, the flowable material can be cured, avoiding unnecessary cooling.

Displacement of the material inlet relative to the mobile mould matrix causes a break in the flowable material linking them. This may be aided by the use of a cutting tool. The exposed flowable material of step (iii) may be manipulated prior to contacting it with the forming member. For example, exposed rubber could be rolled down to contact an exposed surface of a tyre casing.

The article on whose surface the moulding is to be formed may be of any desired shape, and similarly the mobile mould matrix, material inlet and forming member may be appropriately shaped.



The invention, however, is particularly useful in forming mouldings as annular layers on toroidal or cylindrical cores. In particular, the invention may be used for moulding tyre treads onto tyre casings.

The flowable material may be any material which can be made to flow into the moulding cavity, for example materials such as rubbers or thermoplastics in the melt state, thermosetting resins such as polyurethane in the melt state, or particulate materials which are able to flow. Clearly, when the material inlet is displaced the flowable material at the inlet should be in a sufficiently viscous state to prevent its escape.

By forming the moulding directly onto the surface of the article (e.g. a tyre casing) rather than producing the moulding separately and then attaching it to the surface of the article by curing (e.g. hot capping or cold capping), the overall process time can be reduced significantly, although of course a subsequent capping step may be employed where necessary. The separation of the curing step from the moulding step means that a number of mouldings can be simultaneously cured.

The at least one inlet channel of the material inlet may be shaped so that at the point at which material enters the moulding cavity, it has a reduced cross-section. This causes the rate of flow per unit area to be greater than that in the rest of the material inlet, increasing pressure temporarily, generating deformation energy and heating the flowable material as it enters the moulding cavity. Prior to the reduced cross-section area of the inlet channel, the pressure drop and temperature increase is small, minimising the danger of premature crosslinking and permitting pauses in manufacture without cleaning down of the apparatus being necessary. This forms a further aspect of the present invention. Thus according to the present invention there is also provided injection moulding apparatus for flowable settable material in which work done on the flowable material causes its temperature to be elevated sufficiently to set it (i.e. cure it). The work done on the flowable material may be by injection force against flow resistance.

The material inlet may comprise a plurality of radially disposed inlet channels. Alternatively, it may comprise at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet. For example, there may be a single continuous inlet channel about the whole of the material inlet. This provision of a single inlet channel provides a number of substantial advantages over the prior art devices. In particular it provides for:

- i) a short flow path for mould filling;
- ii) filling in a single sweep, avoiding air entrapment;
- iii) complete avoidance of potentially weak flow interfaces such as occurs when several injection points and long flow paths are used; and
- iv) a balanced radial force on the casing during filling, minimising distortion problems.

The elevated temperature of the flowable material at the start of the curing process results in a shorter curing process time and may additionally improve the performance and wear life of the moulding (e.g. tyre tread) - high temperatures are conducive to oxidative degradation and so the longer that the surface layer of the moulding is held at a high temperature, the more oxidative degradation will occur, and *vice versa*.

The rate of flow of material through the material inlet may be varied as the moulding cavity is filled. For example, it may be reduced for the final material to enter the moulding cavity. This can be used to prevent excessive heating and curing (crosslinking) of residual material in the material inlet, particularly between cycles.

Rather than introduce a measured volume of material into the moulding cavity, a pressure sensor (e.g. transducer) or pressure switch may be used to determine

the pressure being placed upon the flowable material and to stop filling of the moulding cavity when a predetermined level of pressure is reached. This is particularly useful since it means that a variable volume of material may be introduced to the moulding cavity to fill it - in the case of tyre casings, this means that their surface need not be uniform and may e.g. contain pits or hollows. This tolerance of flaws in the surface of the tyre casing can reduce the cost of preparing a tyre casing for retreading and may also allow tyre casings to be retreaded which, due to surface deformation, would not be suitable for retreading using existing techniques such as hot or cold capping.

The material inlet may form a side of the moulding cavity. In the case of the article being a tyre casing, the material inlet may form a tyre-edge side of the moulding cavity.

Thus the material inlet may have e.g. an overall radial shape, allowing filling from all around an article such as a tyre casing. Since a tyre tread will have a patterned outer (circumferential) surface, this provides the advantage that displacing of the material inlet will not affect the patterned surface being formed.

Also provided according to the present invention are apparatus for forming on a surface of an article a moulding from flowable material, comprising a mobile mould matrix, material inlet and forming member, the material inlet being displaceable relative to the mobile mould matrix and the article.

The apparatus may additionally comprise at least one support member for the article - in the case of forming a tread on a tyre casing, the pressures required to form the moulding would cause deformation of the tyre casing and so the provision of a support member (or support members) prevents any deformation from occurring.

The material inlet may additionally comprise a material injection system, for example comprising a screw pre-plasticisation unit into which is fed the flowable material in the solid state, the plasticised flowable material being forced into an injection cylinder from where a hydraulic injection ram actuator exerts force on it, causing it to fill the moulding cavity. The injection cylinder may be heated.

It may be desirable to be able to use the material injection system to form a range of mouldings, e.g. different tyre treads on different sized tyre casings, using a range of mobile mould matrixs and material inlets. Thus the material inlet may be removably attached to the material injection system.

The forces required to cause the flowable material to fill the moulding cavity and to subsequently form the moulding may be quite substantial - in the case of retreading a tyre casing using a rubber, a maximum force of about 12 MPa, and an average force of about 4.5 MPa, has to be exerted upon the material. Thus the mobile mould matrix must be capable of withstanding such forces - each quadrant of a mobile mould matrix and forming member used to exert 4.4 MPa of pressure in forming a tyre tread on a tyre casing will have approximately 98 tonne of opening pressure force exerted upon it.

The mobile mould matrix may comprise a segmented mould which is joined together to define the inner shape of the mobile mould matrix, i.e. that which will define the moulding cavity. A retaining ring may be placed around the segmented mould and a cam or cams attached to allow it manipulation. A support assembly may also be used to provide mechanical support for the mobile mould matrix, particularly for holding the edge forming member in place and exerting sufficient force upon it.

Despite the teachings of the prior art such as US 4139582 which states that in order to successfully fill a moulding cavity defined about a tyre casing, injection of

rubber must be from the equatorial plane of the moulding cavity, the present inventors have now found that, surprisingly, injection of flowable materials into a tyre casing or other cylindrical or toroidal moulding cavity may be effected from the side of the moulding cavity. The inventors have found that this need not result in the formation of weak weld lines and thus the products of such moulding operations are mechanically sound.

Thus the present invention also provides a method of forming from flowable material a moulding on a surface of a toroidal or cylindrical article having at least one side wall, comprising the steps of:

i) contacting the surface with a mobile mould matrix having either one continuous inlet on the side wall or a plurality of discontinuous inlets along the length of the side wall, and simultaneously contacting the inlet or each of the inlets with an injection port, the mobile mould matrix and the injection ports defining a moulding cavity;

ii) filling the moulding cavity via the inlets with flowable material;

iii) stopping filling and displacing the injection port or each of the injection ports relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the injection port or injection ports into the moulding cavity being severed;

iv) sealing the inlet or each of the inlets; and

v) curing the flowable material to complete the moulding.



Such a toroidal or cylindrical article could be a tyre casing. The point of injection into the side wall could be anywhere on the side wall.

The invention will be further apparent from the following description, with reference to the several figures of the accompanying drawings, which show, by way of example only, one form of tyre retreading apparatus. Of the figures:

Figure 1 shows cross-sectional views of a mobile mould matrix, material inlet and article (tyre casing) whilst the moulding cavity is being filled ("fill step") (Figure 1a) and when the material inlet is displaced to sever the connection with the moulding cavity ("crop" step) (Figure 1b). Cross-hatched area (also in Figures 4 and 7) indicates the cross-section of circular inlet channel 131;

Figure 2 shows (Figures 2a and 2b) support members forming a support assembly for a tyre casing;

Figure 3 shows the tyre casing support assembly of Figure 2, the tyre casing being contacted by edge forming member and mobile mould matrix;

Figure 4 shows the arrangement of Figure 3, together with a material injection system, a datum/support for the apparatus, and an actuator for controlling filling and displacing the material inlet.

Figures 5 shows (Figures 5A-5C) an alternative material inlet arrangement in use;

Figure 6 shows (Figures 6A and 6B) another alternative material inlet arrangement, having material injection ports; and

Figure 7 shows the embodiment of Figures 5A-5C in use.

### Example 1

In a first embodiment (Figures 1-4), moulding apparatus 10 for forming a moulding on the outer surface of tyre casing 20 from rubber 11 comprises support members 30, 31, 32, 33 (also labelled "A" in the Figures) and 40, 41, 42, 43 (also labelled "B" in the Figures) for tyre casing 20, support members 30-33, 40-43 being held in place by locking/mounting ring 50 (also labelled "C" in the Figures). Mobile mould matrix 60 comprises segmented mould 70 having heater elements 80, 81, 82, 83 and retaining ring 90 (also labelled "E" in the Figures) which holds segmented mould 70. Cams 100, 101 (also labelled "F" in the Figures) are attached to segmented mould 70 to manipulate it. Material inlet 110 comprises control ring 120 and circumferential inlet 130 having inlet channel 131. Mobile mould matrix 60, casing 20 and material inlet 110 together define moulding cavity 140 having a first volume. Similarly, mobile mould matrix 60 and heated forming member 230 together define moulding cavity 140 having a second volume. Inlet channel 131 has a reduced cross-sectional area at the point at which rubber 11 will enter moulding cavity 140. The first and second volumes of mould cavity 140 are equal.

Circumferential inlet 130 is removably attached to material injection system 150 which comprises pressure transducers 151, 152, injection cylinder 160 having heater 161, screw pre-plasticisation unit 170 and hydraulic injection ram actuator 180.

Support plate 190 acts as a datum for the apparatus as a whole, ensuring the correct positioning of material inlet 110 and mobile mould matrix 60. Control ring 120 is attached to actuator 200. Forming member 230 (also labelled "D" in the Figures) contacts mobile mould matrix 60 and has heater elements 220, 221.

In use, a tyre casing 20 is prepared for retreading by inserting support members 30-33 and then support members 40-43. Support members 30-33 widen as the radius increases, and support members 40-43 narrow as the radius increases giving tapered junctions between them. Locking/mounting ring 50 is then placed into the orifice defined by support members 30-33 and 40-43, locking them in position and providing means for subsequently mounting tyre casing 20. As can be seen from Figures 2a and 2b, support members 30-33 and 40-43 and locking/mounting ring 50 are arranged to redistribute radially acting forces in the circumferential direction. As can be seen from Figure 4, support members 30-33, 40-43 are arranged to redistribute forces mainly on the side of material inlet 110 where high forces are exerted. Tyre casing 20 is then contacted by mobile mould matrix 60, which is positioned by referencing locking/mounting ring 50 using cams 100, 101. The use of cams 100, 101 in bringing together mobile mould matrix 60 and material injection system 150 results in the edge of inlet 130 contacting casing 20 and the force exerted being transmitted across casing 20 to press the edge of mould 70 against casing 20. Thus a positive sealing force is exerted against the rubber pressure without affecting any other aspect of the filling operation.

Whilst this is being done, material injection system 150 and inlet channel 131 are charged with rubber 11 ready for supply to moulding cavity 140 when it has been formed. Actuator 200 positions control ring 120 over inlet channel 131 to prevent escape of rubber 11, pre-plastication unit 170 is activated and rubber 11 in the solid state is fed into it. The deformation energy exerted upon solid rubber 11 is converted into heat, sufficient to change the rubber 11 into a plastic/melt state. As the material injection system 150 and inlet channel 131 fills with rubber 11, air is vented and injection ram actuator 180 exerts a small back pressure and is forced back (i.e. is retracted) by rubber 11. Once ram actuator 180 has been fully retracted and the pressure detected by transducers 151, 152 has reached a predetermined level, material injection system 150 and material inlet 131 are charged and ready to fill moulding cavity 140. Rubber 11 is kept in the plastic/melt state by heater 161.



The assembly of tyre casing 20 and mobile mould matrix 60 is then contacted with material inlet 110, control ring 120 being simultaneously retracted by actuator 200 and opening inlet channel 131, thus defining moulding cavity 140. Material inlet 110 is connected to material injection system 150, which also contacts locking/mounting ring 50 to ensure correct positioning of tyre casing 20 and mobile mould matrix 60 relative to material inlet 110.

Ram actuator 180 then forces rubber 11 out of material injection system 150, through inlet channel 131 and into moulding cavity 140. Flow resistance caused by the reduced cross-section part of inlet channel 131 causes deformation energy to be generated, heating rubber 11 as it enters moulding cavity 140. Heaters 80, 81, 82, 83 heat mobile mould matrix 60 and moulding cavity 140. Once ram actuator 180 has been extended by at least a first predetermined amount, meaning that about 0.5 litres of rubber is needed to complete filling, the rate of extension of ram actuator 180 is reduced in order to reduce the heating of the final rubber 11 to enter moulding cavity 140. Once ram actuator 180 has been extended by at least a second predetermined amount and transducers 151, 152 detect a pressure of at least a predetermined amount, moulding cavity 140 has been filled with rubber 11. Actuator 200 is then extended, causing control ring 120 to lift mobile mould matrix 60 away from circumferential inlet 130 and simultaneously closing inlet channel 131, severing the flow of rubber from material inlet 110 (i.e. circumferential inlet 130) into moulding cavity 140. Cams 100, 101 then displace material inlet 110 relative to mobile mould matrix 60 and the outer surface of tyre casing 20, leaving exposed rubber 11.

Inlet channel 131 and material injection system 150 may once again be charged with rubber 11.

Mobile mould matrix 60 and the outer surface of tyre casing 20 are then contacted with forming member 230 to form moulding cavity 140 defining a second volume and causing the exposed rubber 11 to contact the outer surface of tyre casing 20.

The rubber 11 is then cured by heating it using heaters 231, 232, 80-83. Forming (shaping) has already been completed.

### Example 2

In a second embodiment (Figures 5A-5C, 7), a more robust and mechanically simpler apparatus is provided. The use of the apparatus is extremely similar to that of the previous embodiment. Notably, control ring 120, support plate 190 and actuator 200 do not form part of the second embodiment. Control ring 120 is replaced by an extended circumferential inlet 130, which additionally comprises high temperature thermoplastic seal 300. Heater 161 and transducers 151, 152 are not shown.

In use, the tyre casing 20 is prepared for retreading as before with support members 30-33, 40-43 and locking/mounting ring 50. Mobile mould matrix 60 is placed around casing 20. The inlet apparatus differs significantly from those of Figure 1, not having control ring 120 and related actuating and supporting means, simplifying the apparatus significantly. Inlet 130 is extended in size, obviating the need for control ring 120. Inlet 130 is also provided with high temperature thermoplastic seal 300 which is slightly deformable (without affecting the surface of the tyre tread to be formed) and ensures a sealing of mould cavity 140 whilst making the sealing a more mechanically tolerant process. The shoulder region dimensions of prepared tyre casings vary, and the seal arrangement of this embodiment enables the creation of sealed mould cavities 140 where there is such dimensional variance. Material inlet 110 and mobile mould matrix 60 are mounted on tyre casing 20 to define mould cavity 140. Mould cavity 140 is then filled as before with rubber 11 through circumferential inlet channel 131. Material inlet 110 is then displaced relative to casing 20 and mobile mould matrix 60 to leave exposed

flowable material, the rubber 11 connecting that attached to tyre casing 20 and that in inlet channel 131 simply tearing as it is stretched.

Mobile mould matrix 60 and the outer surface of tyre casing 20 are then contacted with forming member 230 to form moulding cavity 140 defining a second volume. In order to prevent deformation of rubber 11 resulting from expansion of volatiles in rubber 11 this should be done within two minutes (preferably less) from the removal of material inlet 110. The rubber 11 is then cured by heating it using heaters 231, 232, 80-83. Forming (shaping) has already been completed. Whilst this forming and curing step takes place, material inlet 110 can be used in a subsequent retreading process with a different tyre casing 20 and mobile mould matrix 60.

### Example 3

In a third embodiment (Figures 6A-6B), rather than use a circumferential inlet channel 131, a series of 12 injection ports 401-412 are used to simultaneously inject rubber 11 into moulding cavity 140 through inlets 421-432. The method of operation is exactly the same as for Example 2, except that upon removal of injection ports 401-412 from inlets 421-432 of mobile mould matrix 60, inlets 421-432 are then filled with sealing plugs 441-452. Rubber 11 is then cured.

Inlet channel 131 actually comprises circular distribution channel 460 to which rubber 11 is fed from injection cylinder 100 by radial feed channels 461-464.

Sections 471,472,473,474 are blocked sections of circular distribution channel 460 which prevent the creation of regions of stagnation.

Positions 480 are regions of convergent flow where viscous heating is substantially uniform.

In an alternative embodiment, adjacent injection ports are paired up, each pair being fed by one of six radial feed channels 490.

It will be appreciated that it is not intended to limit the invention to the above example only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof as defined by the appended claims.

**CLAIMS**

1. A method of forming on a surface of an article a moulding from flowable material comprising the steps of:
  - i) Contacting the surface with a mobile mould matrix and material inlet having at least one inlet channel to form a moulding cavity defining a first volume, the material inlet being displaceable relative to the surface and the mobile mould matrix;
  - ii) Filling the moulding cavity via the at least one inlet channel of the material inlet with flowable material;
  - iii) Stopping filling and displacing the material inlet relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the material inlet into the moulding cavity being severed;
  - iv) Contacting the exposed flowable material, the mobile mould matrix and the surface with a forming member to form a moulding cavity defining a second volume; and
  - v) Curing the flowable material to complete the moulding.
2. A method according to claim 1, the surface of the article having a cylindrical or toroidal shape.
3. A method according to claims 1 or 2 the article being a tyre casing.

4. A method according to any one of the preceding claims, the flowable material being a rubber or thermoplastic in the melt state or a thermosetting resin in the melt state or a particulate material.
5. A method according to any one of the preceding claims, the at least one inlet channel having a reduced cross-section at the point at which material enters the moulding cavity.
6. A method according to any one of the preceding claims, said material inlet comprising a plurality of radially disposed inlet channels.
7. A method according to any one of claims 1-5, said material inlet having at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet.
8. A method according to claim 7, having a single continuous inlet channel about the whole of said material inlet.
9. A method according to any one of the preceding claims, the rate of flow of material into the moulding cavity being varied.
10. A method according to claim 9, the rate of flow of material into the moulding cavity being reduced prior to filling being stopped.
11. A method according to any one of the preceding claims, filling being stopped when the level of pressure upon the flowable material reaches a predetermined level.

12. A method according to any one of the preceding claims, the material inlet forming a side of the moulding cavity.
13. A method according to claim 12, the article being a tyre casing and the material inlet forming a tyre-edge side of the moulding.
14. Apparatus for forming on a surface of an article a moulding from flowable material, comprising a mobile mould matrix, material inlet and forming member, the material inlet being displaceable relative to the mobile mould matrix and the article.
15. Apparatus according to claim 14 additionally comprising at least one support member for the article.
16. Apparatus according to either one of claims 14 or 15, the material inlet additionally comprising a material injection system.
17. A method of forming from flowable material a moulding on a surface of a toroidal or cylindrical article having at least one side wall, comprising the steps of:
- i) contacting the surface with a mobile mould matrix and material inlet having either one continuous inlet channel on the side wall or a plurality of discontinuous inlet channels along the length of the side wall, and simultaneously contacting the inlet channel or each of the inlet channels with an injection port, the mobile mould matrix and the injection ports defining a moulding cavity;
  - ii) filling the moulding cavity via the inlets with flowable material;
  - iii) stopping filling and displacing the injection port or each of the injection ports relative to the mobile mould matrix and the surface to leave exposed flowable

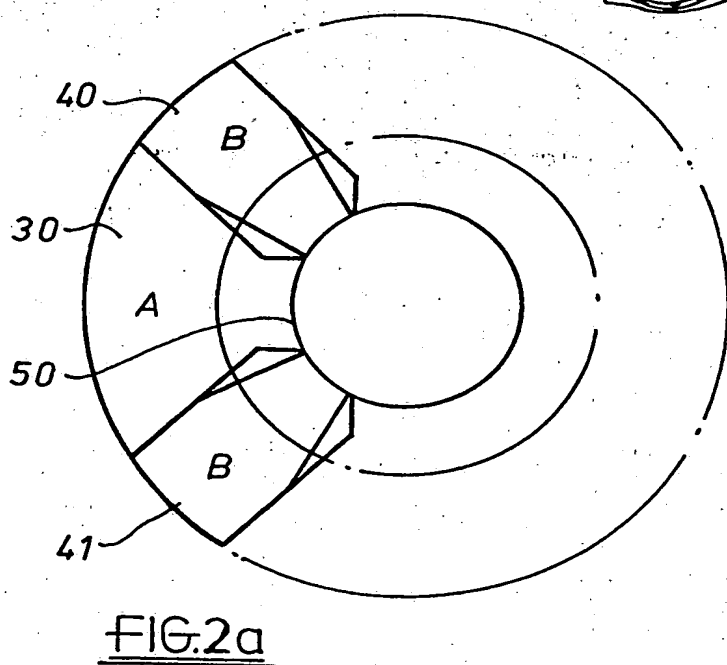
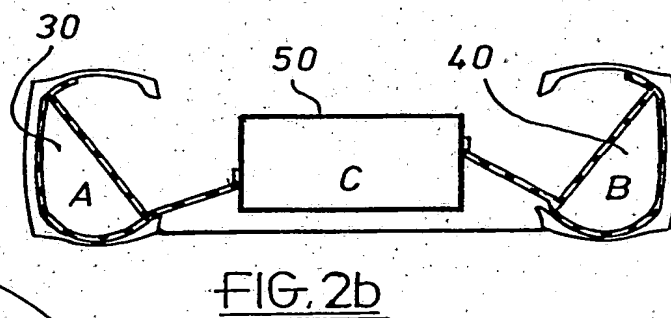
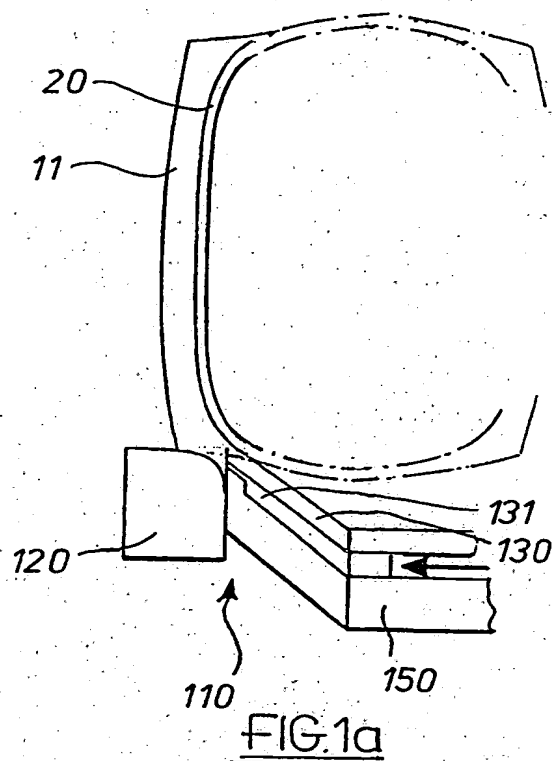
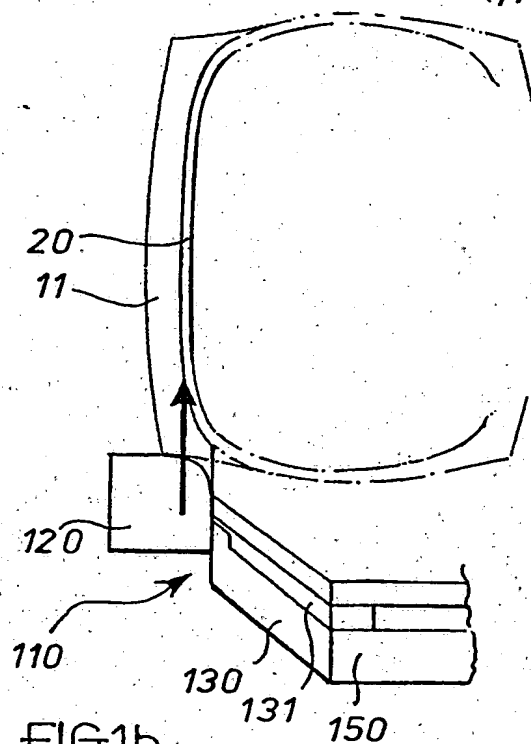
material, the flow of material from the injection port or injection ports into the moulding cavity being severed;

iv) sealing the inlet or each of the inlets; and

v) curing the flowable material to complete the moulding.



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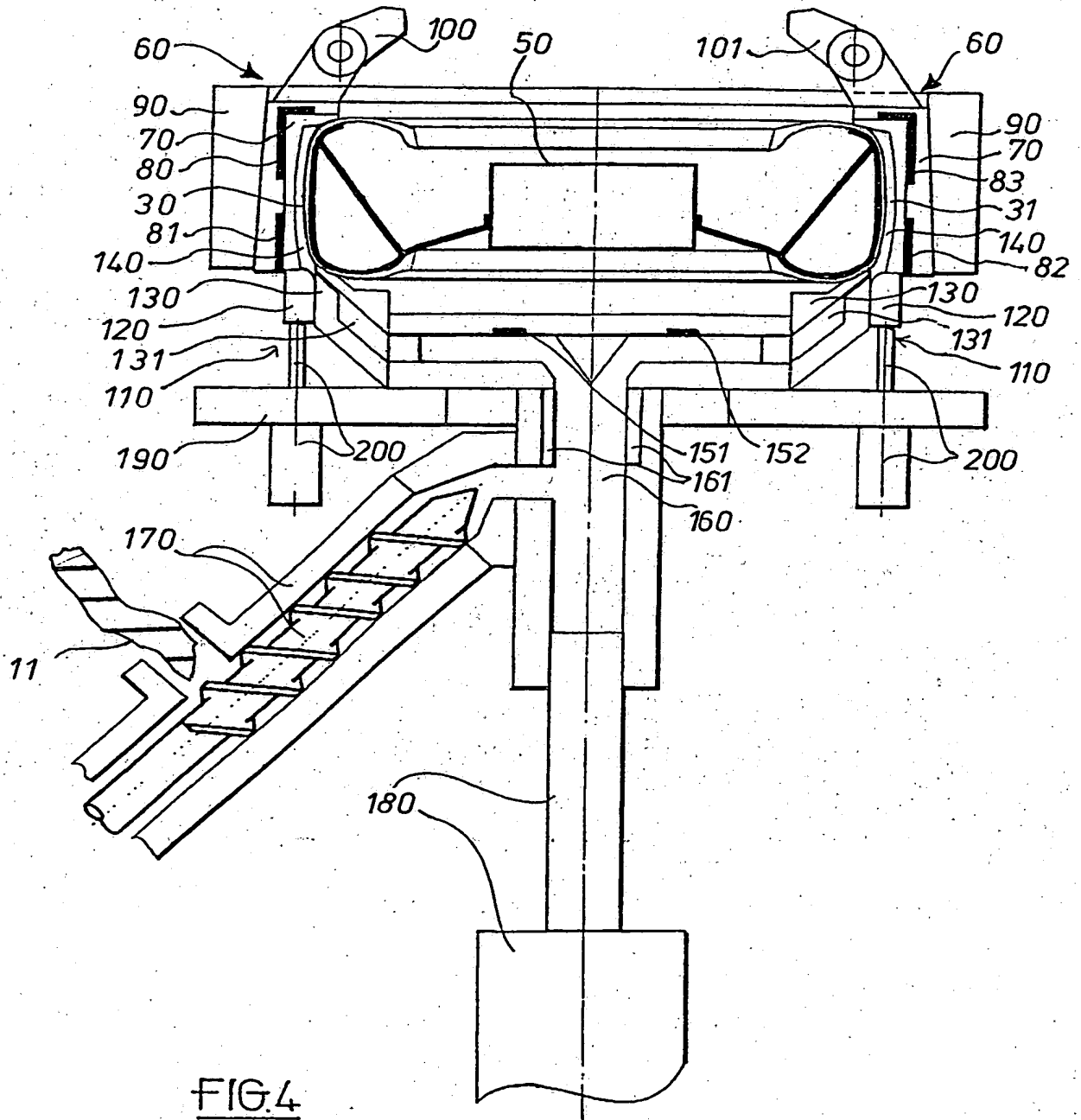


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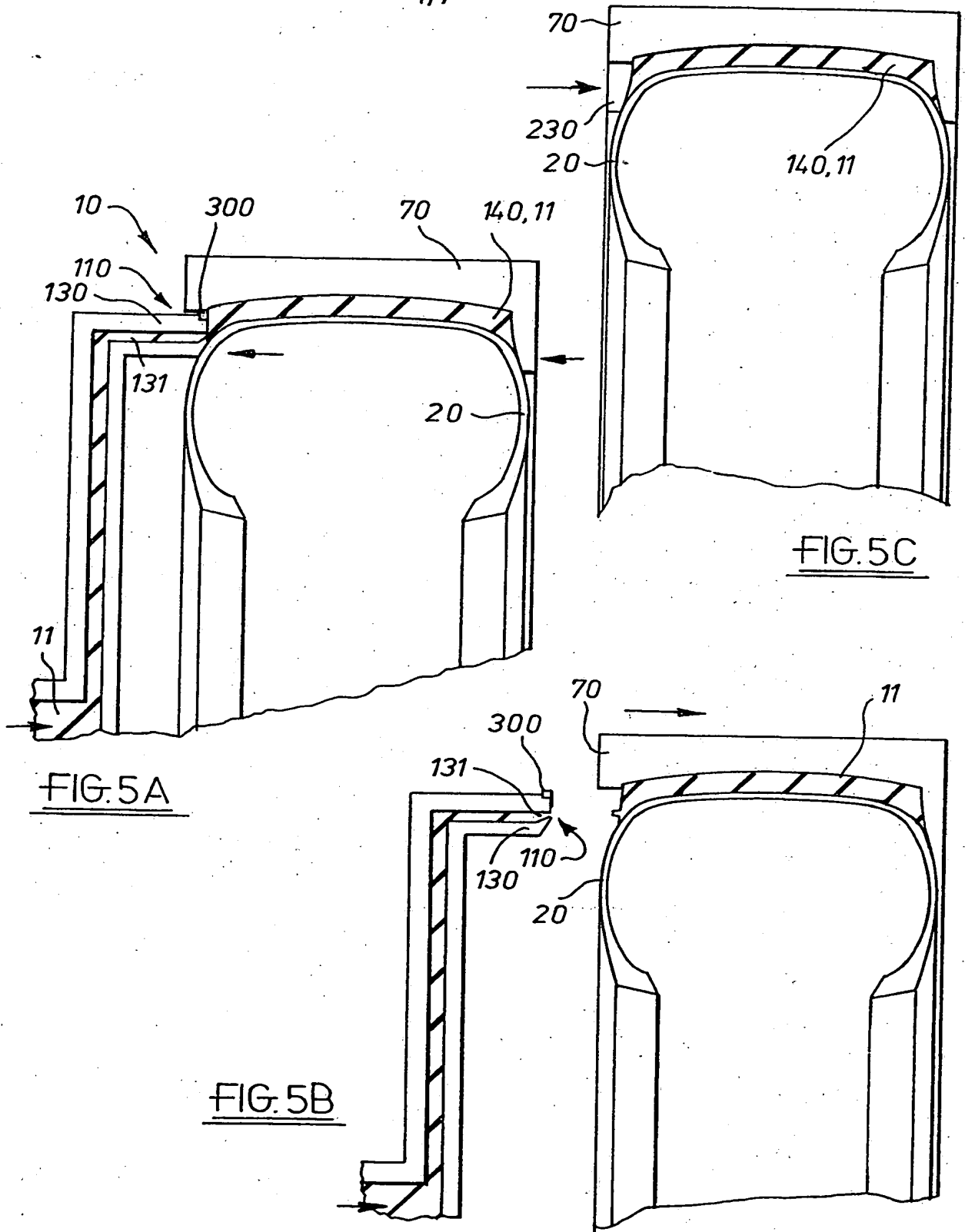
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23 JAN 2002



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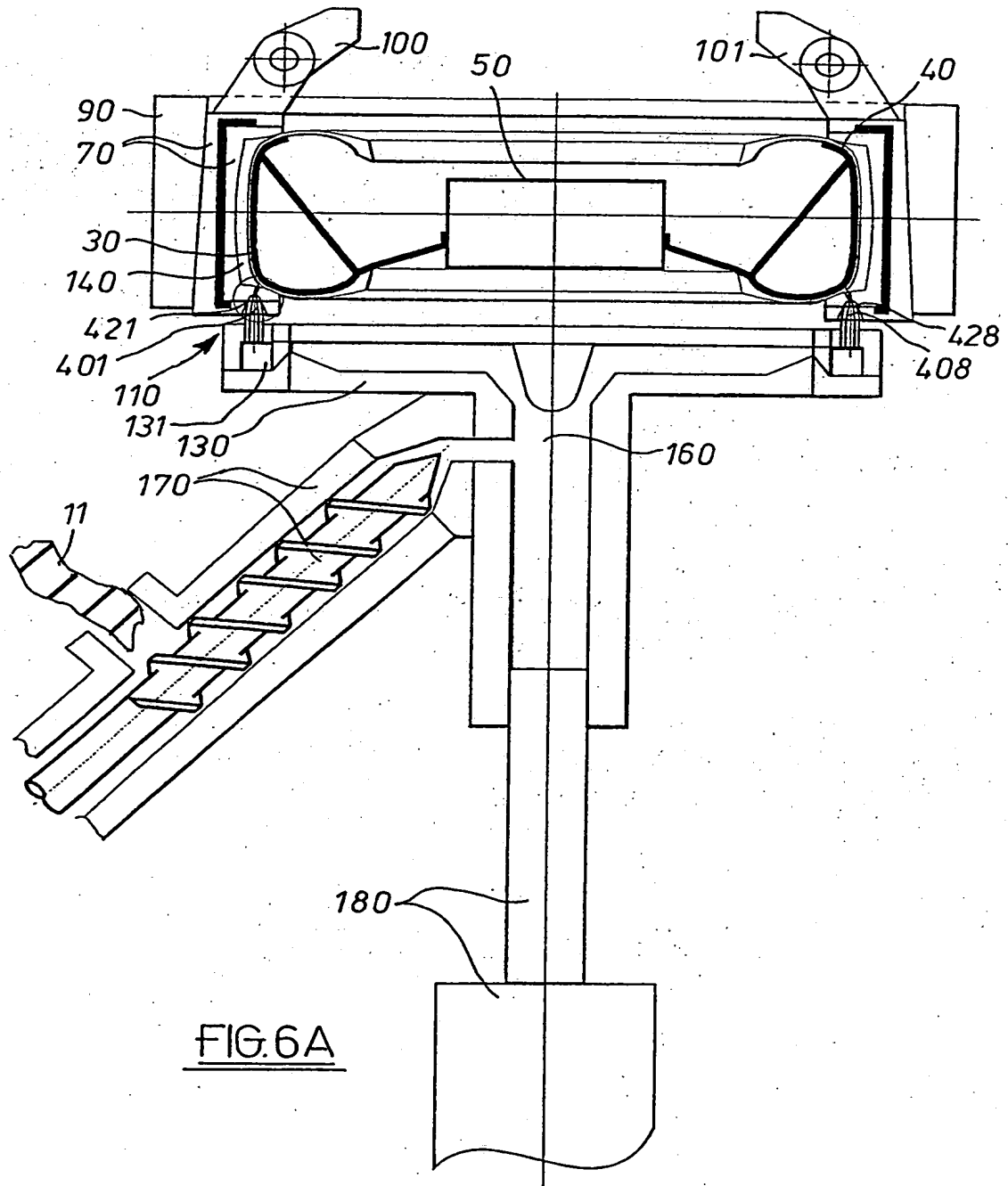
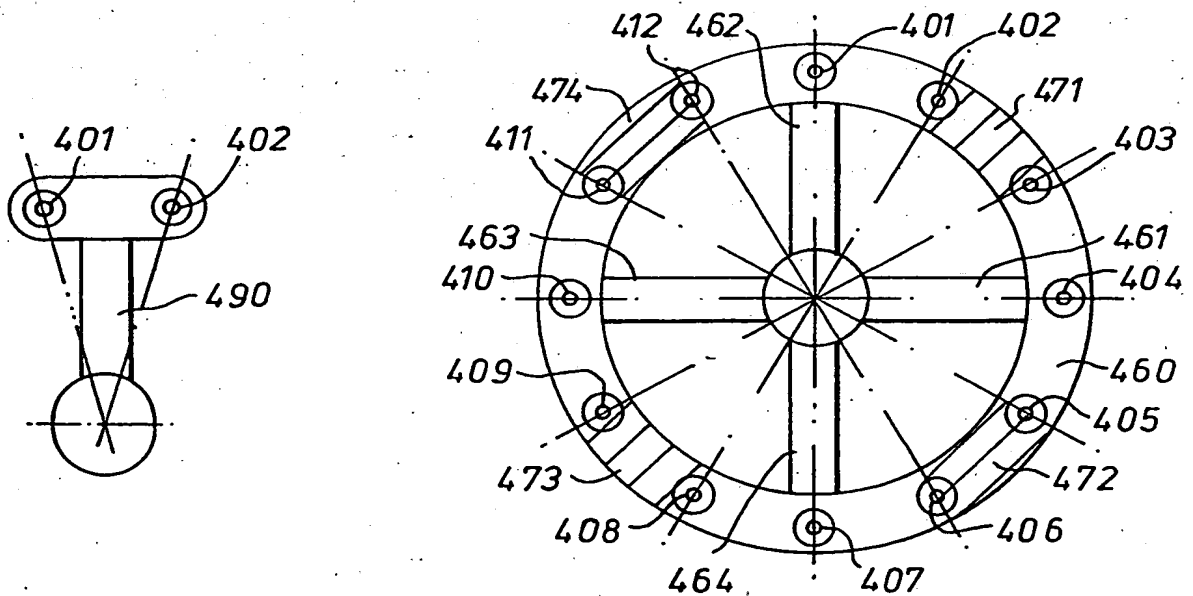
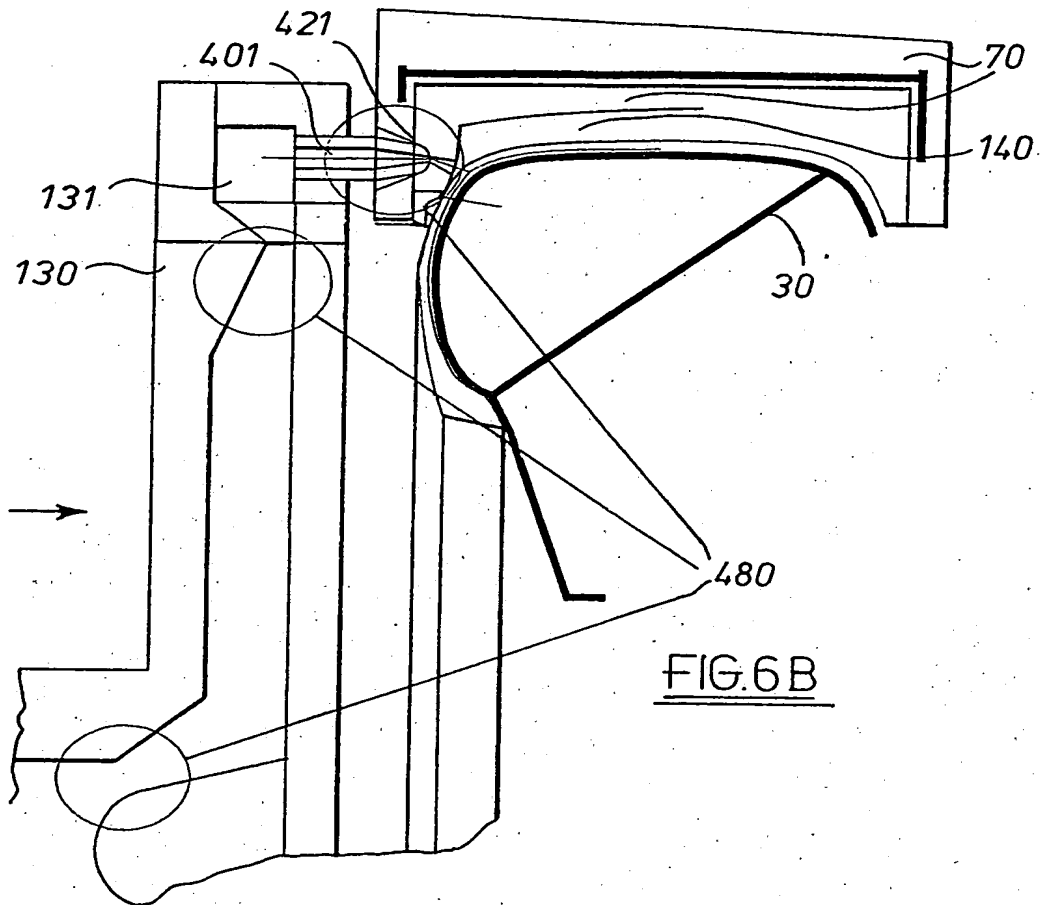


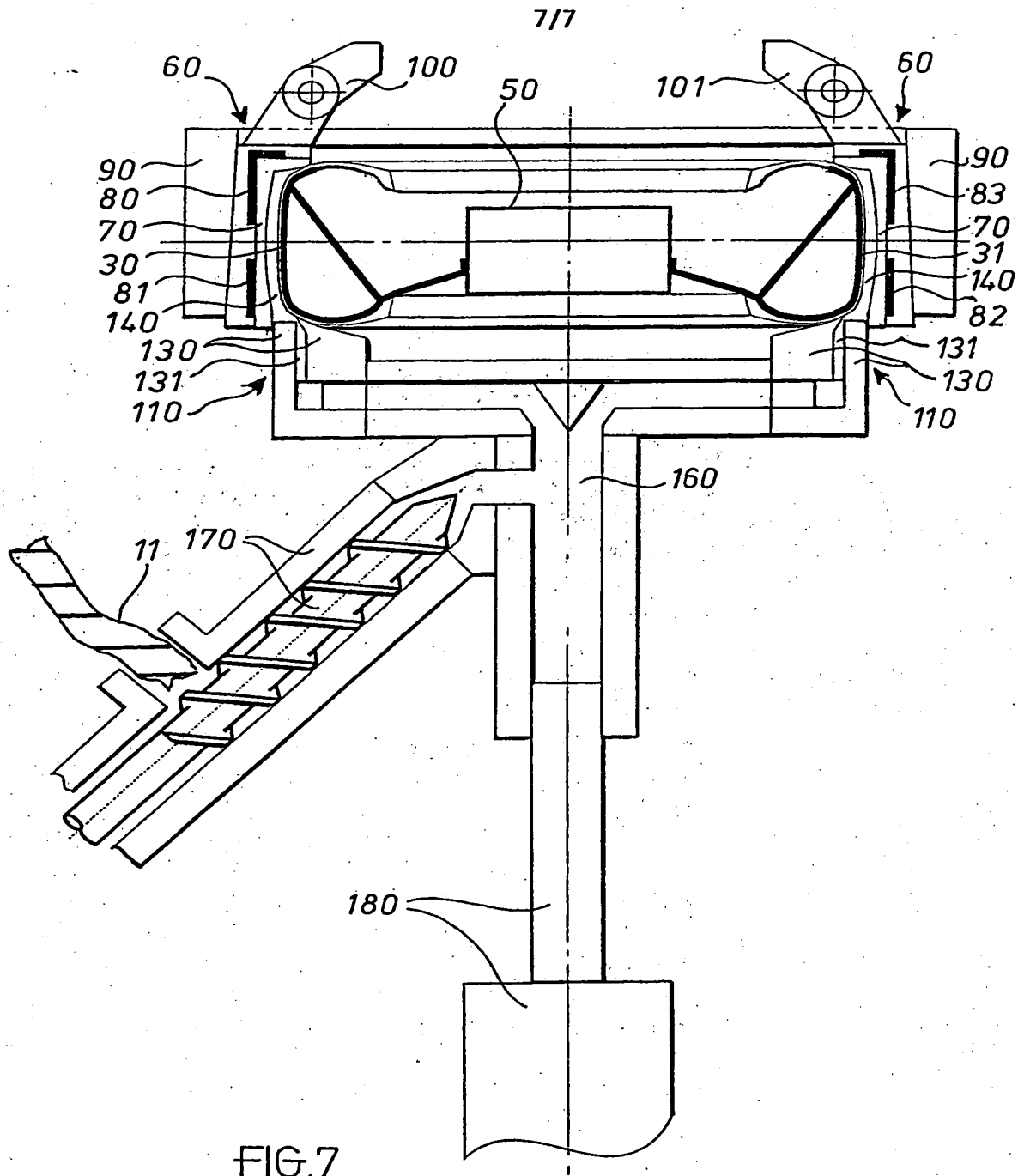
FIG. 6A

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# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 00/02828

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29D30/62 B29C45/28 B29C45/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29D B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.         |
|------------|---|-------------------------------|
| X          | US 3 134 137 A (R. C. IMMEL )<br>26 May 1964 (1964-05-26)<br><br>column 4, line 66 -column 6, line 3;<br>figures 5-9  | 1,4,5,<br>7-12,14,<br>16      |
| A          | FR 2 072 999 A (REIFENKOMBINAT FURSTENWA)<br>24 September 1971 (1971-09-24)<br><br>page 4, line 14 -page 5, line 18; figures<br>2,3   | 1-5,<br>7-12,<br>14-17        |
| A          | PATENT ABSTRACTS OF JAPAN<br>vol. 015, no. 404 (M-1168),<br>15 October 1991 (1991-10-15)<br>-& JP 03 166916 A (YOKOHAMA RUBBER CO<br>LTD:THE), 18 July 1991 (1991-07-18)<br>abstract; figures 1,2 | 1,2,4,5,<br>7-12,14,<br>16,17 |
|            | -/--  |                               |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

27 October 2000

Date of mailing of the international search report

06/11/2000

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                     | Relevant to claim No. |
|------------|--|-----------------------|
| A          | US 2 569 935 A (C. W. LEGUILLON ET AL.)<br>2 October 1951 (1951-10-02)<br>the whole document           | 1-6,<br>10-17         |
| A          | US 2 744 290 A (W. G. CORSON)<br>8 May 1956 (1956-05-08)<br>figures 5,7<br>column 3, line 12 - line 71 | 1-17                  |



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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/02828

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s)  | Publication<br>date      |
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| US 3134137                                | A | 26-05-1964          | NONE                        |                          |
| FR 2072999                                | A | 24-09-1971          | DE 2058109 A<br>SU 382269 A | 25-11-1971<br>22-05-1973 |
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| US 2744290                                | A | 08-05-1956          | NONE                        |                          |

